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Two new *Telmatobius* species (Leptodactylidae, Telmatobiinae) of Ancash, Peru

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The taxonomic status of two populations of telmatobiine frogs in the Peruvian department Ancash is evaluated using data from external morphology. The intrapopulational variation of 18 morphometric measures is compared with those of six telmatobiine species from adjacent regions: *Batrachophrynus brachydactylus, B. macrostomus, Telmatobius brevirostris, T. carrillae, T. jelskii* and *T. rimac*. The frogs inhabiting the Laguna Conococha and those of the Rio Sihuas are distinct from the already described species and from each other. They represent two new species of the genus *Telmatobius*. Diagnostic features of external morphology and skin histology are given to distinguish among the central Peruvian Telmatobiinae.

INTRODUCTION

The streams and lakes of the central and northern regions of the Peruvian Andes are inhabited by leptodactylid frogs of the genera *Telmatobius* Wiegmann, 1835 and *Batrachophrynus* Peters, 1873 (DUELLMAN, 1979; SINSCH, 1990; WIENS, 1993). *Batrachophrynus* is endemic to central Peru, whereas *Telmatobius* has a widespread distribution ranging from Ecuador in the north to Chile and Argentina in the south (CEI, 1986). The taxonomic status of populations of telmatobiine frogs is difficult to evaluate, if only based on external morphology, because shape and coloration are usually similar due to the adaptation to the mostly riparian habitats. The original descriptions and diagnoses of most species are inadequate and the taxonomic classification of populations often requires comparison with type material. In many taxa, multivariate statistics such as discriminant analyses are necessary to distinguish between intraspecific and interspecific variation of morphometric measures (WIENS, 1993; SINSCH et al., 1995). In others, genetic markers such as allozyme loci are used to assess the specific status (WIENS, 1993). These approaches were recently used to evaluate the status of several populations inhabiting the Andean regions of the northern Peruvian departments of Amazonas, Cajamarca, La Libertad and Piura (WIENS, 1993) and of the central Peruvian departments of Ancash, Ayacucho, Cerro de Pasco, Huancavelica, Huanuco, Junin and Lima (SINSCH et al., 1995; SINSCH & JURASKE, 1995). The known species of the north-Peruvian departments are *Telmatobius brevipes* Vellard, 1951, *T. ignavus* Barbour & Noble, 1920, *T. latirostris* Vellard, 1951, and the six species recently described by WIENS (1993), *T. atahualpai*, *T. colanensis*, *T. degener*, *T. necopinus*, *T. thompsoni* and *T. truebae*. The reassessment of the status of the central Peruvian populations led to the recognition of *Batrachophrynus brachydactylus* Peters, 1873, *B. macrostomus* Peters, 1873, *Telmatobius brevirostris* Vellard, 1955, *T. carrillae* Morales, 1988, *T. jelskii* (Peters, 1873) and *T. rimac* Schmidt, 1954.

Information on the Telmatobiinae inhabiting the department of Ancash are still scarce. The few populations which have been treated taxonomically have been assigned to three species of *Telmatobius*: *T. rimac* (VELLARD, 1955; MORALES, 1988*a*), *T. jelskii* (MORALES, 1988*a*) and *T. carrillae* (MORALES, 1988*b*; SALAS, 1990). The most recent checklist of amphibian species of Peru (RODRÍGUEZ et al., 1993) recognizes only the occurrence of *T. carrillae* and *T. rimac* in Ancash. A thorough survey of the amphibians of this region during eight years (1986-1994) by the senior author revealed the existence of two populations of telmatobiine frogs which apparently differed in some characters of external morphology from these species and others known to inhabit the adjacent central Peruvian departments (SALAS, unpublished data). These observations motivated the senior author to reevaluate the taxonomic assignment of telmatobiine frogs collected in Ancash and preserved in local collections. The morphometric analysis (using the classification criteria of SINSCH et al., 1995) of the specimens collected in the Rio Huaylas and assigned to *T. jelskii* by MORALES (1988*a*) showed that they had been confounded with *T. rimac* (SALAS, in preparation). In contrast, the populations of telmatobiine frogs collected in the Laguna Conococha and in the Rio Sihuas remained unidentified, though the first superficially resembles *Batrachophrynus brachydactylus*, and the second *Telmatobius carrillae*. Both populations differ in several aspects from all other species and also between each other.

The aims of this paper are to: (1) establish the distinction of the populations inhabiting the Laguna Conococha and the Rio Sihuas from the already described species of this region; (2) describe two new species; and (3) justify their inclusion in the genus *Telmatobius*.

MATERIAL AND METHODS

The material examined included adult frogs pertaining to six previously known species (*Batrachophrynus brachydactylus*, N = 53; *B. macrostomus*, N = 13; *Telmatobius brevirostris*, N = 5; *T. carrillae*, N = 43; *T. jelskii*, N = 71; *T. rimac*, N = 42), and 25 unclassified specimens which were collected in the Laguna Conococha, Provincia Recuay, Department of Ancash, Peru (13 adults, 2 subadults), and in the Rio Sihuas, Provincia Sihuas, Department of Ancash, Peru (10 adults), respectively. The geographical distribution of the collection sites are shown in figure 1. The detailed list of specimens of the 6 previously known species, with their localities and museum collections, was already published by SINSCH et al. (1995: 43-44, Appendix I). As for the 25 unclassified specimens, their detailed list is given below under the two newly described species. Institutional abbreviations are as follows: KU, Museum of Natural History, The University of Kansas, USA; MHNSM, formerly MHNJP, Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima, Peru; URP, Museo de Historia Natural, Universidad Ricardo Palma, Lima, Peru; ZFMK, Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany.

Standard morphometric measurements were recorded from all adult specimens to the nearest 0.1 mm with needle-tipped calipers, as in WIENS (1993) and SINSCH et al. (1995). Note that measurements of limbs refer to the portions of body containing the bones: (1) SVL, snout-vent length; (2) BH, height of body (at the pectoral girdle); (3) HWID, maximum width of head; (4) EYE, eye diameter; (5) IOD, interorbital distance; (6) ENOSE, eye-nostril distance (anterior margin of eye to posterior edge of naris); (7) ESNOUT, distance between the eye and the tip of the snout; (8) HUML, humerus length (upper forelimb); (9) RADL, radioulnar length (lower forelimb, elbow to distal edge of outer palmar tubercle); (10) HNDL, hand length (proximal edge of outer palmar tubercle to tip of third finger); (11) FG3L, length of the third finger; (12) FEML, femur length (thigh); (13) TIBL, tibia length (shank, knee to heel); (14) FOOTL, foot length (from union with tibia to the tip of fourth toe); (15) TOE1L, length of first toe; (16) TOE4L, length of fourth toe; (17) CIL, length of callus internus; (18) WEBL, maximum length of toe web between III and IV (from the middle of the web, i.e. lowest part, to the union of the toes).

Multivariate analyses were performed on $\log_{10}$-transformed data (BOOKSTEIN et al., 1985) and morphometric ratios. The empiric measurements were transformed to ratios (range: 0-1) by calculating measures relative to SVL (SINSCH et al., 1995). Moreover, two indices were used for further analysis: CIL/TOE1L and FEML/TIBL.

The first step of classification was to calculate the discriminant scores for the adult specimens from the Laguna Conococha and Rio Sihuas using the discriminant functions published by SINSCH et al. (1995), which distinguish among *Batrachophrynus brachydactylus*, *B. macrostomus*, *Telmatobius brevirostris*, *T. carrillae*, *T. culeus*, *T. jelskii* and *T. rimac*. The second step consisted in subjecting sets of the $\log_{10}$-transformed data to principal component analysis to explore the morphometric variability independent of taxonomic assignment. Data sets were: (1) *Batrachophrynus brachydactylus*, *B. macrostomus*, taxon from Rio Sihuas and taxon from Laguna Conococha; (2) *Telmatobius brevirostris*, *T. carrillae*, *T. jelskii*, *T. rimac*, taxon from Rio Sihuas and taxon from Laguna Conococha. Principal components (PC) are linear combinations of the measured variables, uncorrelated with each other and explaining the maximum amount of variation. The first principal component (PC1) of morphometric data generally describes differences in size, but size effects may be present in subsequent principal components (HUMPHRIES et al., 1981). Techniques such as shearing have been developed to correct PC2 and PC3 for possible size effects (BOOKSTEIN et al., 1985), but they are controversial and size effects may still persist (ROHLF & BOOKSTEIN, 1987). Therefore, we present the uncorrected PC2 and PC3. The next step consisted in a stepwise canonical discriminant analysis to distinguish between the taxonomic groups delimited a priori. We used stepwise forward selection of variables (criterion to enter: $F = 4.0$) to minimize the number of variables needed for group distinction. The resulting discriminant functions (CAN: canonical variables) are linear combinations of those measured variables that maximize the differences between the groups. Discriminant functions were derived from the $\log_{10}$-transformed data. The final step of analysis was to look for diagnostic morphometric ratios which differ significantly among the known species and the taxa from Conococha and Sihuas. We applied a multiple range test using the Least Square method and a significance level of 1 %. All calculations were performed on a Pentium PC using the program package STATGRAPHICS Plus, version 1.4.

The descriptions of the new species follow the format of TRUEB (1979) and WIENS (1993). The diagnosis only distinguishes among the species included in this paper. The formulae for toe webbing follow SAVAGE & HEYER (1967) as modified by MYERS & DUELLMAN (1982).

RESULTS AND DISCUSSION

CLASSIFICATION WITH THE DISCRIMINANT FUNCTIONS WHICH DISTINGUISH AMONG THE CENTRAL PERUVIAN SPECIES

The morphometric features of the adult frogs which were collected in the Laguna Conococha and in the Rio Sihuas are listed in Tables I and II. The corresponding data for *Batrachophrynus brachydactylus*, *B. macrostomus*, *Telmatobius brevirostris*, *T. carrillae*, *T. jelskii* and *T. rimac* have been published by SINSCH et al. (1995: Tables I-II).

Eighteen $\log_{10}$-transformed morphometric characters were used to obtain discriminant functions which distinguish among the described telmatobiine species of central Peru (SINSCH et al., 1995: Tables III-IV). The first step of classification consisted in calculating the scores for the adult individuals of the Conococha and Sihuas samples using these discriminant functions. If the unclassified frogs are conspecific with any of the described central Peruvian species, we expect that the discriminant scores are completely or at least to a large amount within the known ranges of these species.

The discriminant scores based on the functions which distinguish among *Batrachophrynus brachydactylus*, *B. macrostomus*, *Telmatobius brevirostris* and *T. carrillae* are shown in figure 2. All scores of the specimens from Rio Sihuas are placed outside the variation of any of the known species with respect to CAN1 and CAN2. In contrast, the scores of the Conococha individuals completely overlap with the range of variation of *T. brevirostris*. However, the scores obtained using CAN3 distinguish both Conococha and Sihuas specimens from *T. brevirostris*. In a three-dimensional plot of these discriminant functions there is no overlap of the distributions obtained for the samples from Laguna

Conococha and from Rio Sihuas with that of *Batrachophrynus brachydactylus*, *B. macrostomus*, *Telmatobius brevirostris* or *T. carrillae*. In conclusion, the telmatobiine frogs of the unclassified populations remain unidentified and are probably not conspecific with any of these species.

The same analysis was done applying the discriminant functions which distinguish among *T. culeus*, *T. jelskii* and *T. rimac*. The distribution of scores obtained for the frogs of the two unclassified populations does not overlap with the range of *T. culeus*, but some scores are inside the ranges of *T. jelskii* and *T. rimac* (fig. 3). Nevertheless, most scores of both populations are outside the ranges of either *T. jelskii* or *T. rimac*, especially those of the frogs from Laguna Conococha. These results do not suggest that the unclassified frogs pertain to either species, but due to the slight overlap conspecificity cannot entirely be ruled out. However, the frogs of Rio Sihuas are not only morphometrically similar to *T. jelskii* and *T. rimac*, but also share the presence of yellow-orange patches on the ventral side of the thigh with these two species.

Only *T. rimac* is known to occur in Ancash, in three localities along the occidental cordillera (SALAS, in preparation), whereas the nearest locality of a *T. jelskii* population is situated more than 300 km south of the unclassified populations (VELLARD, 1955; SINSCH et al., 1995). The centres of distribution of *T. jelskii* are clearly the more southern departments of Ayacucho, Junin and Huancavelica. Considering our limited knowledge on the distribution of most Peruvian Telmatobiinae, the biographical argument against the conspecificity with *T. jelskii* is admittedly weak.

Finally, we have to consider the characters related to sexual maturity. A diagnostic character for *T. jelskii* among the central Peruvian Telmatobiinae is the presence of horny excrescences on the chest of reproductive males. This feature is not shared by the males collected in the Laguna Conococha and in the Rio Sihuas. The minimum size of the Conococha adults is about 67 mm SVL (Table I); two smaller individuals (54 mm and 57 mm SVL) were still sexually immature. At all localities and elevations so far known, *T. jelskii* and *T. rimac* reach maturity at a considerably smaller size: 47 mm and 42 mm SVL, respectively. In contrast, the size distribution of the Rio Sihuas frogs clearly falls within the range of these species.

In conclusion, the morphometric data indicate that the taxon inhabiting the Laguna Conococha is certainly not conspecific with any of the described central Peruvian species. The taxon occurring in the Rio Sihuas is certainly distinct from *Batrachophrynus brachydactylus*, *B. macrostomus*, *Telmatobius brevirostris*, *T. carrillae*, *T. jelskii* and *T. culeus*, but some individuals cannot be morphometrically distinguished from *T. rimac*.

MORPHOMETRIC DISTINCTION OF THE UNCLASSIFIED TAXA FROM THE CENTRAL PERUVIAN SPECIES

In the second step of classification, we applied principal component and discriminant analyses to distinguish the unidentified populations from described central Peruvian species. Analyses were performed on two data sets: (1) *Batrachophrynus brachydactylus*, *B. macrostomus* and the samples from Rio Sihuas and Laguna Conococha; (2) *Telmatobius* *brevirostris*, *T. carrillae*, *T. jelskii*, *T. rimac* and the samples from Rio Sihuas and Laguna Conococha.

Generally, the interspecific differences in size (PC1) by far exceeded those in shape (PC2, PC3). The size effects on PC2 and PC3 appeared to be small, because shearing showed little effect. Discriminant analysis led to an optimal separation of species by combining differences in size and shape.

In the data set used to distinguish the Conococha and Sihuas taxa from the *Batrachophrynus* species, the first three principal components explained 95.4 % of the total variance. PC1 accounting for 88.9 % of total variance separates the large *B. macrostomus* from the smaller *B. brachydactylus* and the unidentified taxa. The plot of PC2 (3.9 % of total variance) and PC3 (2.6 % of total variance) scores shows that the scores of the similar-shaped *B. brachydactylus* and *B. macrostomus* form one completely overlapping group, and those of the Conococha and Sihuas taxa another group (fig. 4A). The slight overlap between the two groups is due to scores of the Conococha taxon, whereas the scores of Sihuas taxon vary outside the range of the *Batrachophrynus* species. A perfect separation of the four taxa – 100 % of the specimens correctly classified – was obtained by stepwise discriminant analysis (fig. 4B, Table III). The taxa are distinguished based on only four out of 18 variables: FG3L, HUML, RADL and TOE4L, i.e. parameters of limb morphology.

In the data set used to distinguish the Conococha and Sihuas taxa from the central Peruvian *Telmatobius* species, the first three principal components accounted for 84.4 % of the total variance. PC1 accounting for 71.4 % of total variance separates the small *T. carrillae* from the larger taxa. The plot of PC2 (8.1 % of total variance) and PC3 (4.9 % of total variance) scores shows a complete separation of Conococha taxon from *T. brevirostris*, *T. jelskii* and *T. rimac*, but a considerable overlap with *T. carrillae* and the Sihuas taxon (fig. 5A). The best separation of the six taxa was obtained by discriminant functions based on a set of 13 out of 18 variables (Table IV). As five discriminant functions are necessary to separate six taxa, a presentation in a single plot would require five dimensions. Therefore, we present, as an example, a plot of CAN1 versus CAN2 which distinguishes *T. carrillae* and *T. jelskii* from all other species (fig. 5B). Based on five discriminant functions, 94.3 % of all specimens were correctly classified. The erroneous classifications were: 1 out of 53 *T. carrillae* which was confounded with *T. rimac*; 5 out of 71 *T. jelskii* which were confounded with *T. brevirostris*, *T. rimac* and the Sihuas taxon, respectively; 5 out of 42 *T. rimac* which were confounded with *T. brevirostris* and *T. jelskii*, respectively. Thus, none of the unidentified specimens was confounded with a known taxon.

In conclusion, the analyses presented demonstrate that the two samples of unidentified telmatobiine frogs represent morphometrically well-defined taxa which can be distinguished without erroneous classification from the six sympatric *Batrachophrynus* and *Telmatobius* species, and from each other.

Taxonomic decisions and generic assignment

The taxa inhabiting the Laguna Conococha and the Rio Sihuas, respectively, possess unique characters that easily and consistantly separate them from the other central

Peruvian Telmatobiinae (external morphology: figs. 6-7; skin histology: HEIN, 1994; HEIN & SINSCH, 1995; SINSCH & HEIN, in preparation). Moreover, there is no indication that any of the unidentified taxa in the department Ancash is conspecific with the north Peruvian *Telmatobius* species which inhabit the Andes near the Huancabamba depression (WIENS, 1993; WIENS, personal communication; SALAS, unpublished observations). Therefore, we conclude that the telmatobiine frogs of the populations inhabiting the Laguna Conococha and the Rio Sihuas are members of new species.

The generic assignment of the new taxa to *Telmatobius* is based on the following considerations. In central Peru, the Telmatobiinae are represented by the genera *Telmatobius* and *Batrachophrynus*. There are two presumptive synapomorphies for the monophyly of *Telmatobius* (WIENS, 1993): frontoparietals fused posteriorly, and nuptial excrescences on finger I only. In contrast, evidence for the monophyly of *Batrachophrynus* is based on allozymes, and on diagnostic features such as the absence of maxillary and prevomerine teeth, and nuptial pads without horny excrescenses (PETERS, 1873; LYNCH, 1978; SINSCH & JURASKE, 1995). *Alsodes* is assumed to be the sister taxon of *Telmatobius* (LYNCH, 1978), though the only presumptive synapomorphy is the presence of an enlarged crista medialis on the humerus in males (WIENS, 1993). However, allozymes and skin morphology rather indicate that *Telmatobius* and *Batrachophrynus* are sister taxa (HEIN & SINSCH, 1995; SINSCH & JURASKE, 1995; SINSCH & HEIN, in preparation): (1) NEI's genetic distances between the species of these genera are low; (2) *Telmatobius* and *Batrachophrynus* share the presence of granular glands with small granules which are absent in *Alsodes* (*A. montanus*); (3) *Telmatobius* (except for *T. carrillae*) and *Alsodes* share the presence of granular glands with large granules, but granules and gland structure are very different in the two genera (SINSCH & HEIN, in preparation); (4) *Telmatobius* and *Batrachophrynus* share the absence of nuptial excrescences on finger II which are present in *Alsodes*. Analyzing the character states considered as diagnostic for the genera *Alsodes, Batrachophrynus* and *Telmatobius* in the two new taxa, we find: (1) horny nuptial excrescences are present only on finger I; (2) maxillary and premaxillary teeth are present; (3) two types of granular glands (small and large granules) are present. A conservative evaluation of these character states suggests a provisional inclusion of the new taxa in the genus *Telmatobius*. Further comparative studies on allozymes, osteological and histological characters are needed and in work to test the validity of this assignment.

ACCOUNT OF THE NEW SPECIES

Telmatobius hockingi sp. nov.

(figs. 8-9)

Holotype. — URP 116, adult male, from Rio Sihuas 5 km from Sihuas, Provincia Sihuas, Departamento Ancash, Peru, 2700 m altitude, 77°38′14″W 08°30′00″S, collected on 19 december 1992 by Antonio W. SALAS.

Paratypes. — URP 112-115 and 117-119, 3 males and 4 females; ZFMK 57260, 1 male; KU 220844, 1 female; all collected at the same site simultaneously with the holotype by Antonio W. SALAS.

Diagnosis. — (1) Premaxillary teeth present; (2) tympanum absent; (3) nuptial spines moderately small on the dorsal and ventral surfaces of the thumb; nuptial pads continuous with inner palmar tubercle; (4) dorsum brownish grey (in preservative) with small patches; (5) venter dark cream with diffuse grey; (6) forelimbs and hindlimbs always without ornamentation or transverse bars; (7) dorsal skin smooth; (8) snout-vent length in males to 52.5 mm, in females to 64.8 mm.

This species resembles in habitus the riparian *Telmatobius* (fig. 8). Confusion with the sympatric *Batrachophrynus* species is impossible due to the difference in adult size, the easily noticeable premaxillary teeth, and the presence of nuptial excrescences and of granular glands with large granules in the dorsal skin. Moreover, the morphometric ratios HWID/SVL and FG3L/SVL are diagnostic for the distinction of *T. hockingi* from *Batrachophrynus* (fig. 6). *T. hockingi* differs from *T. brevirostris*, *T. jelskii* and *T. rimac* by the ratio HUML/SVL, and from *T. carrillae* and the new species described below by the ratio FG3L/SVL (fig. 7). The yellow-orange patches on the ventral side of the thigh distinguish *T. hockingi* from *T. brevirostris*, *T. carrillae* and the new species described below.

Description. — Head slightly narrower than body; head wider than long: HLEN 88.3 % of HWID; head length 30.4 % of SVL; head width 34.4 % of SVL. Dorsal view of snout rounded, in lateral profile gently sloping (fig. 9A). Nostrils not protuberant, located at the extreme anterior terminus of snout, anterolaterally oriented. Canthus rostralis indistinct dorsally, in lateral profile short and elevated; loreal region concave. Eyes protuberant on top of head, eye diameter 29.3 % of head length. Tympanum absent, tympanic annulus conspicuous. Supratympanic fold present and well developed, extending from posterior corner of eyelid to the anteroventral insertion of forelimb. Maxillary and premaxillary teeth embedded in labial mucosa, fanglike and protruding, but easily noticeable when passing on top with finger tips. Dentigerous processes of vomer well developed, five times closer to choanae than to each other, located anterior to choanae; choanae about the same size and circular. Tongue rounded with slightly elevated lateral borders, posteriorly free. Vocal slits absent.

Robust, stout forelimbs. Dermal wrist fold present, but inconspicuous. Fingers uniform in diameter, long and slender; I and II separated due to well developed muscles at the palmar region of insertion. Relative length of fingers: III > IV > I > II (fig. 9B), tips of fingers round to spherical, palmar webbing absent. In males, large and raised nuptial pad covering the dorsal and lateral surface of thumb; nuptial spines, moderately large, conical, keratinized. Inner palmar tubercle oval, continuous with nuptial pad. Outer palmar tubercle oval and large, but smaller than the inner, located proximally on fingers II and III. Conspicuous, supernumerary tubercles close to the base of fingers I and II. Subarticular tubercle present proximally on each finger except III, smaller subarticular tubercles in the middle of each finger and distal ones in III and IV.

Robust, but slender hind limbs. Hind limb length (foot plus tibia) 41.5 % of SVL. Relative length of toes (fig. 9C): IV > III > V > II > I; webbing formula: I 1 − 2+ II 2− − 3 2/3 III 2+ − 3− IV 3− − 1 V; webbing diminishes gradually to form a lateral fringe along the edge of toe IV. Tips of toes spherical and of the same size as finger tips. Inner metatarsal tubercle small, oval and slightly raised; outer metatarsal tubercle round, 1/3 length of inner. Small, round subarticular tubercles distributed on toes as follows: I(1), II(1), III(2), IV(3) and V(2). Tarsal fold extending to 1/3 length of tarsus, confluent with lateral fringe of toe I.

Dorsal, ventral and lateral skin smooth. Ventral skin covered with few and isolated, unconspicuous pustules. Cloacal opening dorsoventrally flattened.

Colour in life. — Dorsum yellowish orange with large irregular shaped black patches, venter creamy yellow with large yellow-orange patches in the pubic region; iris yellow.

Colour in preservative. — Dorsum and dorsal surfaces of limbs blue grey with large dark patches, venter and underside of limbs dull cream with scattered pale grey regions distributed over the whole area, underside of thighs with isolated or connected light patches.

Measurements (mm) of the holotype. — SVL 52.5; BH 14.2, HWID 18.1; EYE 4.7; IOD 12 2; ESNOUT 8.1; HUML 8.9; RADL 13.5; HNDL 12.3; FG3L 7.4; FEML 26.4; TIBL 24.9; FOOTL 40.9; TOE1L 5.6; TOE4L 27.0; CIL 2.6; WEBL 5.8.

Distribution. — *Telmatobius hockingi* is known only from the type locality and from Piscobamba, Ancash.

Ecology. — Frogs of the type series were collected during the day under rocks in a stream (Rio Sihuas) of strongly running water passing through an alder (*Alnus jorullensis*) forest. The stream is used for the irrigation of the adjacent agricultural areas. Sometimes, the stream dries, but small pools persist. These pools and moist soil below rocks are used by the frogs to survive the dry period.

Etymology. — The specific name (a noun in the genetive case) is a patronym for Pedro HOCKING of the Natural History Museum of the San Marcos University (MHNSM), Lima, in recognition for his important contributions to the knowledge of biodiversity of Peru.

Telmatobius mayoloi sp. nov.

(figs. 10-11)

Holotype. — URP 106, adult male, from the mouth of Rio Santa, 500 m from Lake Conococha, Provincia Recuay, Departamento Ancash, Peru, 4050 m altitude, ca. 77°17′50″W 10°06′25″S, collected on 29 december 1992 by Eladio Turya CASTILLO

Paratypes. — URP 103-105 and 107-111, 1 male, 6 females and 1 juvenile, MHNSM 7413 and 7419-7421, 1 male, 2 females and 1 juvenile, ZFMK 57259, 1 female; KU 220842, 1 female; all collected at the same site as the holotype by Antonio W. SALAS.

Diagnosis. — (1) Premaxillary teeth present, almost completely embedded in labial mucosa; (2) tympanum absent; (3) nuptial spines minute, on dorsal and ventral surface of the thumb; (4) dorsum blue grey (in preservative) with large dark blotches; (5) venter light grey (in preservative) with small black spots; (6) forelimbs and hindlimbs with transverse bars; (7) skin of dorsum smooth; (8) snout-vent length in males to 90.3 mm (MHNSM 7413), in females to 84.3 mm (ZFMK 57259).

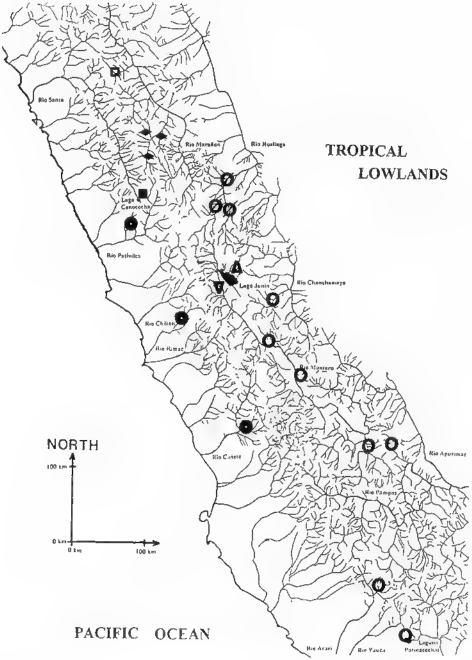

Fig 1. – Distribution of northern and central Peruvian telmatobiine populations. Inverted triangle, *Batrachophrynus brachydactylus*; triangle, *B. macrostomus*; ø, *Telmatobius brevirostris*; rhombus, *T. carrillae*; open square, *T. hockingi*, circle, *T. jelskii*; filled square, *T. mayoloi*; dots, *T. rimac*. Localities are approximated from distances by roads; multiple localities in close proximity are represented by a single symbol. The main Andean river systems and lakes are indicated.

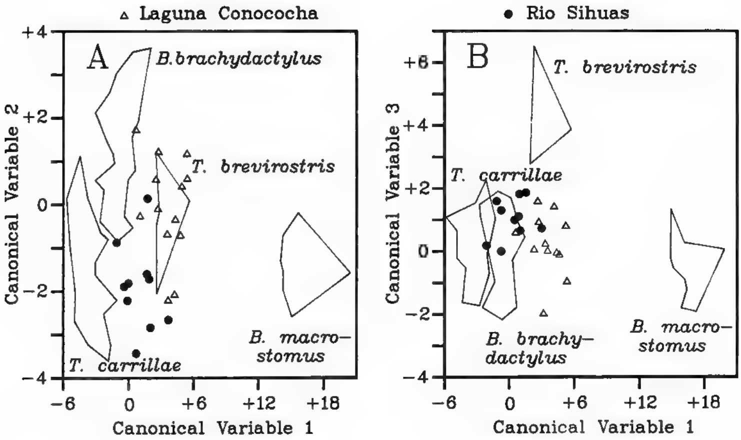

Fig. 2. — Plot of the discriminant function scores obtained for the populations from the Laguna Conococha and Rio Sihuas using the functions which distinguish among the ranges of morphometric variation of *Batrachophrynus brachydactylus*, *B. macrostomus*, *Telmatobius brevirostris* and *T. carrillae* (SINSCH et al., 1995) (A) CAN1 versus CAN2. (B) CAN1 versus CAN3.

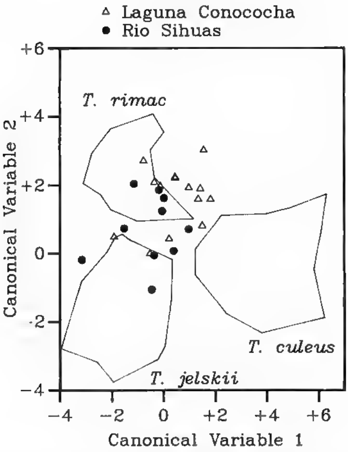

Fig. 3. – Plot of the discriminant function scores obtained for the populations from the Laguna Conococha and Rio Sihuas using the functions which distinguish among the ranges of morphometric variation of *Telmatobius culeus*, *T. jelskii* and *T. rimac* (Sinsch et al., 1995).

This species externally resembles *Batrachophrynus brachydactylus*, the only sympatric telmatobiine species similar in size and coloration (fig. 10). The morphometric ratio HWID/SVL is diagnostic for the distinction of *T. mayoloi* from *Batrachophrynus brachydactylus* (fig. 6). Moreover, the presence of embedded premaxillary teeth and nuptial excrescences as well as the rarely occurring granular glands with large granules in the dorsal skin distinguish *T. mayoloi* from *Batrachophrynus*. *T. mayoloi* differs from *T. brevirostris*, *T. jelskii* and *T. rimac* by the ratio HUML/SVL, and from *T. carrillae* and *T. hockingi* by the ratio FG3L/SVL (fig. 7).

Description. – Head width almost equal to body width; head width and length almost equal: HLEN 97 % of HWID, head length 34 % of SVL; head width 35 % of SVL. Dorsal view of snout rounded, in lateral profile similar to *T. atahualpai* (fig. 11A). Nostrils not

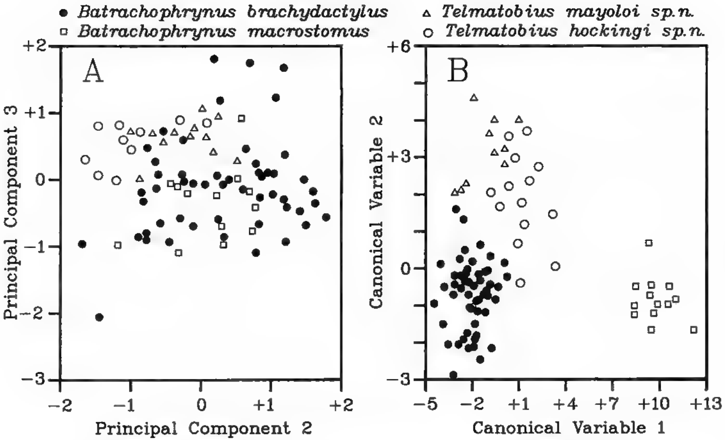

Fig. 4 – Plot of (A) principal component scores and (B) discriminant function scores of *Batrachophrynus brachydactylus*, *B. macrostomus*, *T. hockingi* and *T. mayoloi*. Discriminant functions (1-3) and classification success are given in Table III.

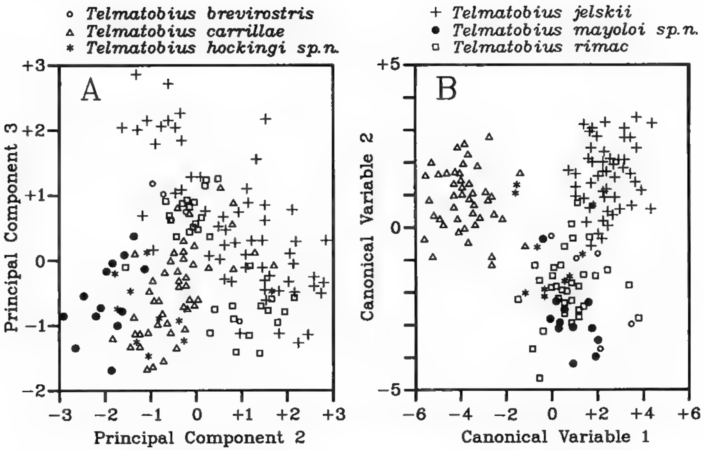

Fig. 5. — Plot of (A) principal component scores and (B) discriminant function scores of *Telmatobius brevirostris*, *T. carrillae*, *T. hockingi*, *T. jelskii*, *T. mayoloi* and *T. rimac*. Discriminant functions (1-5) and classification success are given in Table IV.

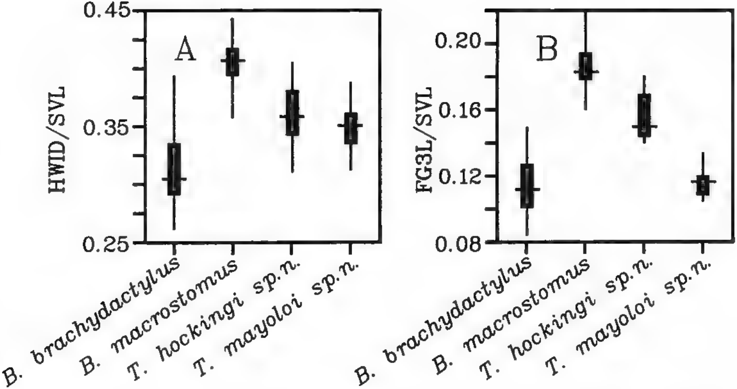

Fig. 6. — Box- and whisker-plot of morphometric ratios which permit the distinction among the *Batrachophrynus* species, *T. hockingi* and *T. mayoloi* (multiple range test, LSD-method, P < 0 01). (A) HWID/SVL: *B. macrostomus* > *T. mayoloi* = *T. hockingi* > *B. brachydactylus*. (B) FG3L/SVL: *B macrostomus* > *T. hockingi* > *B. brachydactylus* = *T. mayoloi*.

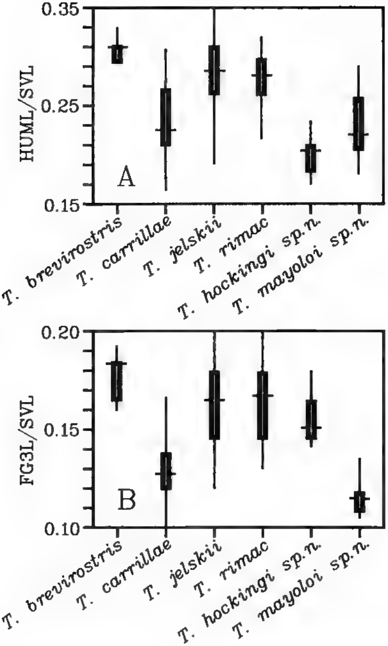

Fig. 7. — Box- and whisker-plot of morphometric ratios which permit the distinction among the known central Peruvian *Telmatobius* species, *T. hockingi* and *T. mayoloi* (multiple range test, LSD-method, $P < 0.01$) (A) HUML/SVL: *T. brevirostris* = *T. jelskii* = *T. rimac* > *T. carrillae* = *T. mayoloi* = *T. hockingi* (B) FG3L/SVL: *T. brevirostris* = *T. jelskii* = *T. rimac* = *T. hockingi* > *T. carrillae* = *T. mayoloi*.

FIG. 8. — Photograph of a male *Telmatobius hockingi*

protuberant, located at the anterior terminus of snout. Canthus rostralis indistinct dorsally, in lateral profile short and elevated. Eyes not protuberant on top of head, eye diameter 27 % of head length. Tympanum absent, tympanic annulus inconspicuous Supratympanic fold present, extending from posterior corner of eyelid to insertion of forelimb. Maxillary and premaxillary teeth embedded in labial mucosa, slightly protruding, but almost unnoticeable when passing on top with finger tips. Well developed vertical fold posterior to corner of jaw, extending below supratympanic fold to throat. Dentigerous processes of vomer large and well developed, three times closer to choanae than to each other, located slightly anterior to choanae; choanae small and oval. Tongue large and rounded, attached through its complete length. Vocal slits absent.

Robust forelimbs, triangular shaped in cross section. Dermal wrist fold conspicuous, but weakly developed. Relative length of fingers: III > IV > II > I (fig. 11B), tips of fingers bluntly pointed, palmar webbing absent, lateral fringes absent. In males, inner palmar tubercle large and oval, continuous with nuptial pad. Outer palmar tubercle elliptical, about 2/3 of size of the inner. One large subarticular tubercle present proximally on each finger, smaller subarticular tubercles present along the longitudinal axis of each finger. In males, densely packed nuptial spines forming plush-like pads, extending on dorsal, medial ventral surface of thumb.

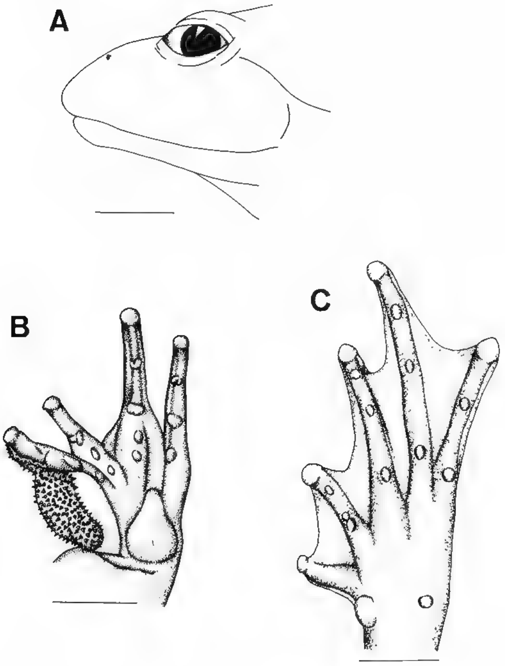

Fig 9 – Morphological details of male holotype URP 123 of *Telmatobius hockingi* (A) Lateral view of head. (B) Palmar view of right hand. (C) Plantar view of left foot Scales = 5 mm

Fig. 10. — Photograph of a male *Telmatobius mayoloi*.

Stout hind limbs, dorsoventrally flattened; thighs with bagginess as in the lake-dwelling *B. macrostomus* and *T. culeus*. Hind limb length (foot plus tibia) 47.9 % of SVL. Relative length of toes (fig. 11C): IV > V > III > II > I; webbing formula: I 1 2/3 — 2+ II 1 1/3 — 3— III 2+ 3 1/3 IV 3 1/3 — 1 2/3 V; webbing diminishes gradually to form lateral fringes along the edges of toes II, III, IV and V. Tips of toes spherical in I, II and III, more pointed in IV and V. Inner metatarsal tubercle ovally elongated, raised; outer metatarsal tubercle equally shaped and elevated as inner, but only 2/3 in size. Small, round subarticular tubercles distributed on toes as follows: I (1), II (1), III (2), IV (3) and V (2). Tarsal fold extending to about 50 % of length of tarsus, confluent with lateral fringe of toe I.

Dorsal, ventral and lateral skin usually smooth Ventral skin covered with few and isolated, inconspicuous pustules. Cloacal opening hidden due to the bagginess of skin.

Colour in life. — Dorsum pale brown with orange tone, frequently covered with irregular shaped black blotches which often contain clear spots, forelimbs and hindlimbs with transverse black bars and clear spots as on the dorsum; venter creamy yellow with orange tone and black spots; iris orange with black reticulations.

Colour in preservative. — Dorsum grey with large, irregular shaped blotches; venter light grey with isolated black dots, forelimbs and hindlimbs with transverse bars.

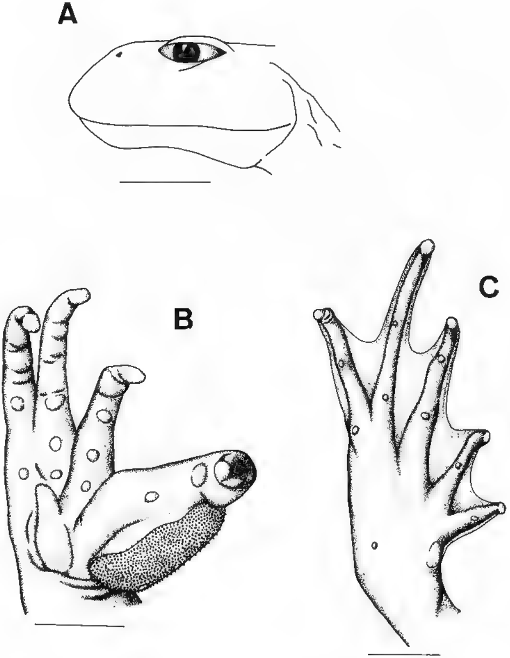

Fig. 11. – Morphological details of male holotype URP 111 of *Telmatobius mayoloi*. (A) Lateral view of head. (B) Palmar view of right hand. (C) Plantar view of left foot. Scales = 5 mm.

Table I. - Morphometric data for *Telmatobius mayoloi* and *T. hockingi*. The first line is mean ± 1 SD; the second line is range. All values are in millimeters; see text for abbreviations of variables.

Character	*Telmatobius mayoloi* Males N = 3	*Telmatobius mayoloi* Females N = 10	*Telmatobius hockingi* Males N = 5	*Telmatobius hockingi* Females N = 5
SVL	78.5± 11.6 67.2 - 90.3	76.3 ± 5.7 69.7 - 84.3	47.7 ± 4.8 42.2 - 52.5	60.1 ± 4.2 53.2 - 64.8
BH	17.8 ± 2.7 15.1 - 20.4	17.0 ± 2.2 14.6 - 21.3	13.9 ± 0.9 12.9 - 15.2	16.6 ± 0.7 15.5 - 17.3
HWID	27.9 ± 4.2 23.6 - 32.0	26.8 ± 3.2 23.4 - 31.8	17.0 ± 0.8 16.2 - 18.1	21.9 ± 1.4 19.8 - 23.7
EYE	6.1 ± 1.0 5.2 - 7.1	5.7 ± 0.4 5.1 - 6.5	4.4 ± 0.6 3.9 - 5.3	4.9 ± 0.4 4.6 - 5.6
IOD	17.5 ± 2.4 15.3 - 20.0	17.6 ± 1.2 15.8 - 19.4	12.1 ± 0.8 11.1 - 13.0	14.2 ± 0.7 13.4 - 15.4
ENOSE	11.3 ± 1.2 10.1 - 12.5	10.6 ± 0.6 9.8 - 11.6	7.6 ± 0.5 7.0 - 8.3	8.8 ± 0.4 8.4 - 9.3
ESNOUT	16.3 ± 2.2 14.1 - 18.5	15.2 ± 1.0 13.5 - 16.7	10.9 ± 1.3 9.1 - 12.6	12.7 ± 0.5 11.9 - 13.3
HUML	19.2 ± 5.8 15.1 - 25.9	17.2 ± 3.1 12.8 - 22.1	9.9 ± 0.6 8.9 - 10.5	11.5 ± 0.7 10.7 - 12.3
RADL	16.7 ± 2.7 13.6 - 18.9	18.6 ± 2.6 14.7 - 23.1	11.8 ± 1.0 11.2 - 13.5	14.8 ± 0.6 13.8 - 15.5
HNDL	15.3 ± 4.1 11.3 - 19.4	15.6 ± 2.6 11.7 - 19.7	11.8 ± 1.3 10.5 - 13.8	14.2 ± 1.7 12.7 - 16.9
FG3L	9.2 ± 1.5 7.8 - 10.8	8.8 ± 1.2 7.3 - 11.5	8.2 ± 2.7 6.5 - 13.0	9.4 ± 1.3 8.6 - 11.6
FEML	35.8 ± 4.6 31.2 - 40.3	34.8 ± 5.3 26.8 - 43.4	23.2 ± 1.9 21.7 - 26.4	28.6 ± 1.0 27.8 - 30.2
TIBL	35.8 ± 4.8 31.4 - 40.9	34.4 ± 4.7 25.4 - 41.4	22.4 ± 1.6 21.3 - 24.9	27.5 ± 1.0 26.5 - 29.0
FOOTL	57.3 ± 7.8 49.9 - 65.5	54.1 ± 6.2 44.2 - 66.0	35.7 ± 3.1 33.0 - 40.9	44.4 ± 2.4 41.6 - 47.1
TOE1L	8.1 ± 1.4 6.6 - 9.3	7.8 ± 0.7 6.3 - 8.6	5.0 ± 0.5 4.3 - 5.6	6.5 ± 0.4 6.1 - 7.0
TOE4L	38.2 ± 6.2 32.3 - 44.6	35.4 ± 4.1 28.2 - 42.6	23.2 ± 2.4 21.1 - 17.0	28.8 ± 1.5 26.9 - 30.9
CIL	3.4 ± 0.8 2.6 - 4.2	3.2 ± 0.5 2.3 - 3.9	2.7 ± 0.4 2.1 - 3.0	3.2 ± 0.4 2.7 - 3.7
WEBL	11.2 ± 1.7 9.5 - 12.8	10.2 ± 2.7 6.7 - 15.7	7.7 ± 2.8 5.3 - 12.2	8.0 ± 1.8 6.0 - 10.6

Table II. - Ratios of morphometric data for *Telmatobius mayoloi* and *T. hockingi*. Data are given as mean ± 1 SD. See text for abbreviations of variables.

Ratio	*Telmatobius mayoloi* N = 13	*Telmatobius hockingi* N = 10
BH/SVL	0.224 ± 0.023	0.287 ± 0.035
HWID/SVL	0 351 ± 0.020	0.361 ± 0.026
EYE/SVL	0 076 ± 0.006	0.087 ± 0.007
IOD/SVL	0.228 ± 0.009	0.246 ± 0.016
ENOSE/SVL	0.141 ± 0.005	0.154 ± 0.010
ESNOUT/SVL	0.201 ± 0.012	0.221 ± 0.014
HUML/SVL	0.228 ± 0.033	0.201 ± 0.020
RADL/SVL	0.237 ± 0.035	0.248 ± 0.016
HNDL/SVL	0.202 ± 0.031	0.242 ± 0.019
FG3L/SVL	0.116 ± 0.010	0.164 ± 0.034
FEML/SVL	0.456 ± 0.044	0.484 ± 0.039
TIBL/SVL	0.451 ± 0.033	0.467 ± 0.026
FOOTL/SVL	0.713 ± 0.041	0.747 ± 0.035
TOE1L/SVL	0.102 ± 0.007	0.107 ± 0.009
TOE4L/SVL	0.468 ± 0.030	0.484 ± 0.020
CIL/SVL	0.042 ± 0.007	0.054 ± 0.008
WEBL/SVL	0.135 ± 0.027	0.147 ± 0.040
FEM/TIBL	1.010 ± 0.068	1.037 ± 0.041
CIL/TOE1L	0.416 ± 0.074	0.516 ± 0.093

Measurements (mm) of the holotype. — SVL 67.2; BH 15.1; HWID 23.6; EYE 5.2; IOD 15.3; ESNOUT 14.1; HUML 15.1; RADL 17.5; HNDL 11.3; FG3L 7.8; FEML 31.2; TIBL 31.4; FOOTL 49.9; TOE1L 6.6; TOE4L 32.3; CIL 3.3; WEBL 9.5.

Distribution. — *Telmatobius mayoloi* is known only from the type locality.

Ecology. — During the day frogs were found under rocks and among submerged plants within the mouth of the Rio Santa. Between 11 00 and 12.00 h, some individuals were observed swimming slowly in river parts with little current. Specimens were never seen outside the water. This species occurs in the Puna. Tadpoles have been found over the year in river pools and will be described in detail elsewhere.

Etymology. — The specific name (a noun in the genetive case) is a patronym for Antuñez de Mayolo, a renowned engineer native from Ancash.

Remarks. — Four of the specimens examined (URP 103-104 and 109, KU 220842) are large gravid females in an externally visible advanced state of egg development. The shape of gravid females is almost ovoid, whereas the shape of non-gravid females and males is slender and spindle-like. The head of the largest female is broad and similar-shaped as in *B. macrostomus*. The thumbs of the reproductive males show well-developed nuptial pads with minute, densely packed spines (fig. 11B). The two smallest individuals

Table III. – Discriminant functions to distinguish among *Batrachophrynus macrostomus*, *B. brachydactylus*, *Telmatobius hockingi* and *T. mayoloi* based on a stepwise discriminant analysis (procedure: forward selection) using 18 log_{10} transformed morphometric characters.

A. Statistical significance

Eigenvalue	Canonical correlation	Wilks Lambda	Chi-Squared	Degrees of Freedom	P
19 00	0.975	0.0093	392.5	12	< 0.00001
2.14	0.825	0.1869	140.9	6	< 0.00001
0 71	0.643	0.5863	44.8	2	< 0.00001

B. Unstandardized discriminant function coefficients

Character (log_{10})	Coefficients of CAN1	Coefficients of CAN2	Coefficients of CAN3
HUML	4.80	-18.27	-0.87
RADL	8 93	6.40	-1.13
FG3L	9.70	2.28	16.85
TOE4L	-0.92	11 65	-21 28
Constant	-23.83	-4.44	17.92

C. Classification success

	Predicted group			
Actual group	*B. brachydactylus*	*B. macrostomus*	*T. hockingi*	*T. mayoloi*
B. brachydactylus	53 (100%)	-	-	-
B. macrostomus	-	13 (100%)	-	-
T. hockingi	-	-	10 (100%)	-
T. mayoloi	-	-	-	13 (100%)

D. Group centroids

Species	CAN1	CAN 2	CAN3
B. brachydactylus	-2 47	-0.83	0 05
B. macrostomus	9.86	-0.77	0 36
T. hockingi	-1.15	3.09	1 46
T. mayoloi	1.07	1.79	-1.69

Table IV - Discriminant functions to distinguish among *Telmatobius brevirostris*, *T. carrillae*, *T. hockingi*, *T. jelskii*, *T. mayoloi* and *T. rimac* based on a stepwise discriminant analysis (procedure: forward selection) using 18 $\log_{10}$ transformed morphometric characters.

A Statistical significance

Eigenvalue	Canonical correlation	Wilks Lambda	Chi-Squared	Degrees of Freedom	P
6.98	0.935	0.0074	899.8	65	< 0.00001
2.23	0.831	0.0592	518.8	48	< 0.00001
1.24	0.744	0.1910	303.8	33	< 0.00001
0.75	0.654	0.4282	155.6	20	< 0.00001
0.33	0.501	0.7488	53.1	9	< 0.00001

B Unstandardized discriminant function coefficients

Character ($\log_{10}$)	Coefficients of CAN1	Coefficients of CAN2	Coefficients of CAN3	Coefficients of CAN4	Coefficients of CAN5
SVL	-22.97	13.63	-17.21	-7.29	14.31
BH	-2.45	0.25	1.12	15.63	5.70
HWID	17.71	9.77	-7.71	-2.42	-11.60
EYE	-64.30	9.49	-1.13	13.69	76.91
IOD	103.47	-24.03	9.64	-22.62	-113.66
ESNOUT	20.77	8.78	15.76	8.15	-2.00
HUML	6.49	6.75	-2.23	-4.28	12.12
RADL	2.37	0.50	-11.28	7.70	-2.43
FG3L	8.77	5.51	6.90	8.02	-3.93
TIBL	-8.95	-23.58	-2.28	-8.86	6.28
TOE1L	-4.00	-15.26	4.33	0.05	-2.45
CIL	-3.06	-3.05	2.30	5.47	3.68
WEBL	-1.00	1.07	-1.99	-5.65	-4.67
Constant	58.94	-6.23	32.74	-1.40	-80.43

C Classification success

Actual group	Predicted group					
	T. brevirostris	*T. carrillae*	*T. hockingi*	*T. jelskii*	*T. mayoloi*	*T. rimac*
T. brevirostris	5 (100%)	-	-	-	-	-
T. carrillae	-	52 (98%)	-	-	-	1 (2%)
T. hockingi	-	-	10 (100%)	-	-	-
T. jelskii	1 (1%)	-	2 (3%)	66 (93%)	-	2 (3%)
T. mayoloi		-	-	-	13 (100%)	-
T. rimac	2 (5%)	-	-	3 (7%)	-	37 (88%)

D Group centroids

Species	CAN 1	CAN2	CAN3	CAN4	CAN5
T. brevirostris	1.65	-1.72	1.24	3.05	2.67
T. carrillae	-4.05	0.63	-0.04	-0.09	0.11
T. hockingi	-0.19	-0.86	-0.25	2.74	-1.15
T. jelskii	2.37	1.37	-0.14	-0.10	0.01
T. mayoloi	0.76	-2.73	-3.46	-0.43	0.24
T. rimac	0.72	-1.86	1.27	-0.61	-0.17

(SVL 54.2 mm and 57.0 mm) without external sexual characters are considered as subadult juveniles.

RESUMEN

Se evalúa la situación taxonómica de dos poblaciones de ranas Telmatobiinae del Departamento de Ancash, Perú, mediante la comparación de la variación intrapoblacional de 18 de sus medidas morfométricas con las de seis especies de telmatobínidos de regiones adyacentes: *Batrachophrynus brachydactylus*, *B. macrostomus*, *Telmatobius brevirostris*, *T. carrillae*, *T jelskii* y *T. rimac*. Las ranas, que habitan la Laguna Conococha y el Rio Sihuas, no son miembros de las otras especies de la región. Las dos poblaciones representan dos especies nuevas del género *Telmatobius*: *T. hockingi* y *T. mayoloi*. Se presenta caracteres diagnosticos de la morfología externa y de histología de la piel para distinguir entre los Telmatobiinae del Perú central.

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